Assignment

ON

Post Harvest Losses



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DEFINITION

The expression "post-harvest losses" means a measurable quantitative and qualitative loss in a given product. These losses can occur during any of the various phases of the post-harvest system.

More details, Postharvest loss can be defined as the degradation in both quantity and quality of a food production from harvest to consumption. Quality losses include those that affect the nutrient/ caloric composition, the acceptability, and the edibility of a given product. These losses are generally more common in developed countries (Kader, 2002). Quantity losses refer to those that result in the loss of the amount of a product. Loss of quantity is more common in developing countries (Kitinoja and Gorny, 2010). A recent FAO report indicates that at global level, volumes of lost and wasted food in high income regions are higher in downstream phases of the food chain, but just the opposite in low-income regions where more food is lost and wasted in upstream phases (FAO, 2013).

From an economic point of view, the sum of the losses in quantity and quality of the products inevitably means losses of money. In addition to direct economic losses, there are those resulting from poor management of post-harvest systems. They are evidenced by a lack of growth in production and in the income of the farmers.

NATURE AND PRINCIPAL CAUSES OF POST-HARVEST LOSSES

Nature	Direct Causes	Indirect Causes
	Premature harvest	Inadequate:
	Poor maturation	-Capital
	Poor threshing	-Professionalism
In weight	Insufficient drying	-equipments
	Insufficient cleaning	-Pesticides
	Birds attack	-Packaging
In quality	Rodent attack	-Transport
	Insect attack	-Organization
	Microorganism attack	Constraints:
	Biochemical change	-Social
Economic	Leakage and waste	-Economic
	Moisture content wrong	-Political

	For storage	
	Inadequate storage	
	Transport techniques	

PRINCIPAL CAUSES OF POST-HARVEST LOSSES

Harvesting

The time of harvesting is determined by the degree of maturity. With cereals and pulses, a distinction should be made between maturity of stalks (straw), ears or seed pods and seeds, for all that affects successive operations, particularly storage and preservation.

Pre-harvest drying (mainly for cereals and pulses)

Extended pre-harvest field drying ensures good preservation but also increases the risk of loss due to attacks by pests (birds, rodents, and insects) and moulds not to mention theft. On the other hand, harvesting before maturity entails the risk of loss through mould development leading to the decay of seeds.

Transport

Much care is needed in transporting a really mature harvest, in order to prevent detached grain from falling on the road before reaching the storage or threshing place. Collection and initial transport of the harvest thus depend on the place and conditions where it is to be stored, especially with a view to threshing.

Post-Harvest drying

The length of time needed for full drying of ears and grains depends considerably on weather and atmospheric conditions. In structures for lengthy drying such as cribs, or even unroofed threshing floors or terraces, the harvest is exposed to wandering livestock and the depredations of birds, rodents or small ruminants. Apart from the actual wastage, the droppings left by these marauders often result in higher losses than what they actually eat. On the other hand, if grain is not dry enough, it becomes vulnerable to mould and can rot during storage. Moreover, if grain is too dry it becomes brittle and can crack after threshing, during hulling or milling, especially for rice if milling takes place longer time (two to three months) after the grain has matured, thus causing heavy losses. During winnowing, broken grain can be removed with the husks and is also more susceptible to certain insects (e.g. flour beetles and weevils). Lastly, if grain is too dry, this means a loss of weight and hence a loss of money at the time of sale.

Threshing

If a harvest is threshed before it is dry enough, this operation will most probably be incomplete. Furthermore, if grain is threshed when it is too damp and then immediately heaped up or stored (in a granary or bags), it will be much more susceptible to attack by micro-organisms, thus limiting its conservation.

Storage

Storage is the art of keeping the quality of agricultural materials and preventing them from deterioration for specific period of time, beyond their normal shelf life. Different crops are harvested and stored by various means depending on the end utilization. Whether the seed will be used for new plantings the following year, for forage being processed into livestock feed, or even for crops to be developed for a special use, the grower must be aware of harvesting and storage requirements toward a quality product. After determining the prescribed use for the crop, timing for harvest and storage is of important consideration. Along with an assessment of when to harvest, the farmer needs to determine the method of harvesting. There are a wide range of storage structures used throughout the world to successfully store horticultural produce. In general the structure needs to be kept cool (refrigerated, or at least ventilated and shaded) and the produce put into storage must be of high initial quality.

Storage is essential for the following reasons:

- Perishable nature of agric. & bio-materials.
- Provision of food materials all year round.
- Pilling/ provision for large scale processing.
- Preservation of nutritional quality.
- Price control and regulation.
- Optimization of farmers gain/ financial empowerment of farmers.
- Opportunity for export market, etc.

Processing

Excessive hulling or threshing can also result in grain losses, particularly in the case of rice (hulling) which can suffer cracks and lesions. The grain is then not only worth less, but also becomes vulnerable to insects such as the rice moth (Corcyra cephalonica).

Marketing

Marketing is the final and decisive element in the post-harvest system, although it can occur at various points in the agro-food chain, particularly at some stage in processing. Moreover, it cannot be separated from transport, which is an essential link in the system.

NATURE OF POST-HARVEST LOSSES

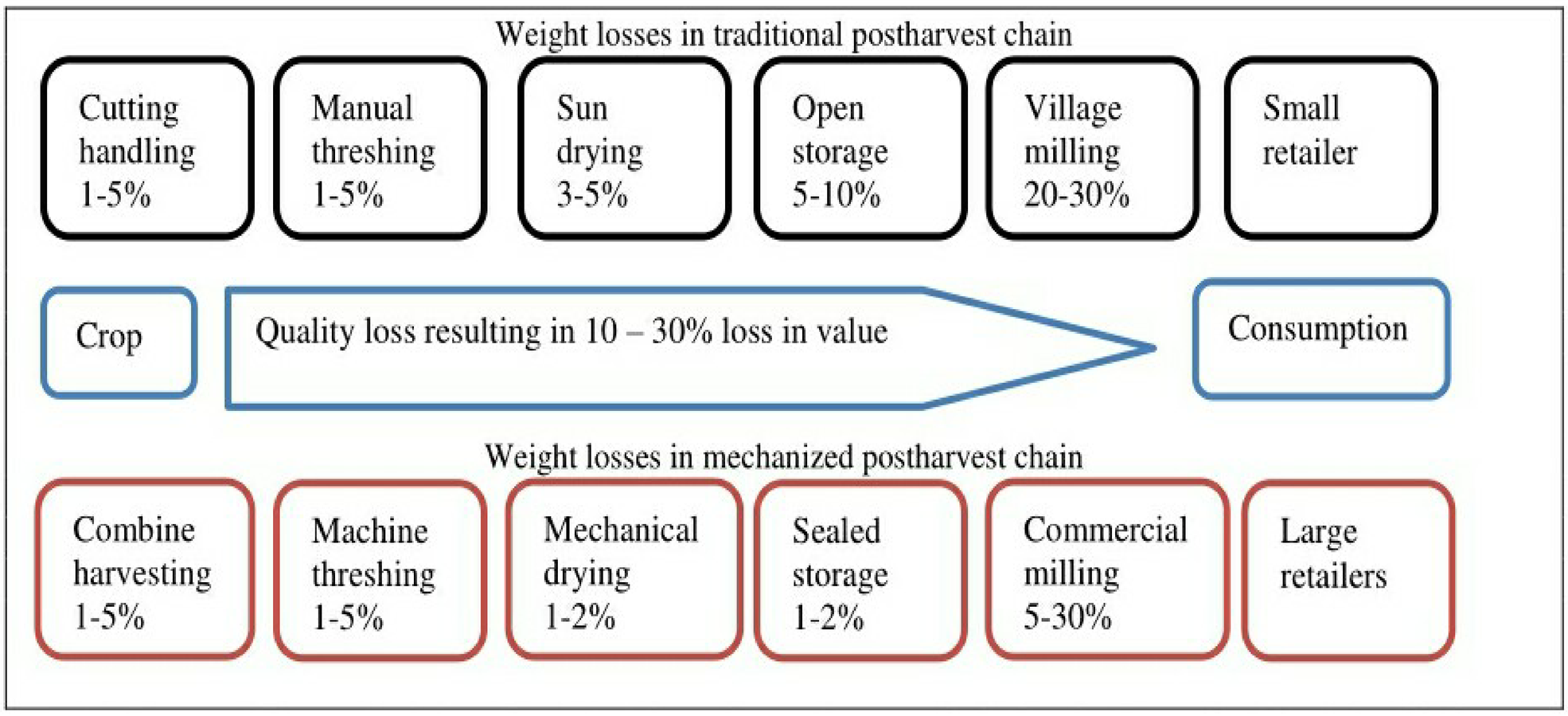


Fig: Estimated losses (weight and quality) from the post-harvest chain for rice in south Asia (After Hodges et al, 2011**)**

Losses in weight

A reduction of the physical substance of the product is evidenced by a loss in weight. Nevertheless, a distinction must be made between loss in weight and loss of product. The decrease of the moisture content brings about a lowering of weight, but this is not a food loss. On the contrary, an increase of weight by absorption of moisture, after rains on a stock in the open air, for example, can cause severe damage and thus considerable losses.

Weight losses are due mainly to the prolonged action of pests (insects, birds, rodents), or to leakage of products (perforated bags, spillage during grain handling, etc.). They can occur at practically any stage of production, but especially during the harvest, storage, and transport. Weight losses caused by pests are not apparent to the casual glance; an inexperienced buyer can thus be fooled. In order to recognize them, one should take an equal volume of clean and sound cereals, grind both samples, and weigh the flour obtained in each case. It will be observed that the damaged sample produces less flour.

This method can also be useful for avoiding potential weight frauds, since it is easy to augment weight by dampening the grain or by adding foreign bodies like pebbles, earth or sweepings.

In order to avoid any confusion, weight loss of dry matter should be stipulated.

Losses in quality

Criteria of quality vary widely and involve the exterior aspect, shape and size, as much as the smell and taste. In this regard, the cultural considerations with which diets and eating habits

are imbued cannot be overlooked.

A clean wholesome product is of primary importance in marketing. By taking a handful of grain from a bag, for example, a tradesman can quickly see if it gives off a floury dust and can therefore deduce whether or not it comes from an infestation by insects. Likewise, a bad smell can lead him to suspect rodent attacks, which can be confirmed by the presence of rat or mouse excrement or hairs. Losses in quality are thus evidenced by a decrease in the market value of the product. These losses are quantifiable only on condition that criteria or standards of quality have been previously established.

On the basis of objective criteria, the quality of the products can be evaluated by fairly complicated tests, measurements and laboratory analyses. Many of the criteria adopted are based on evaluation of standards related to the physical condition of the grain and to its food, nutritive and germinative values. In various countries, quality ratings are based on the general principal according to which grain must be "wholesome, sound, of market quality and odourless". Implicit in this definition are the chief criteria for evaluating the quality of a given batch of grain; these include:

Moisture content: suitable for the storage or further handling of the product.

Colour: homogeneous and appropriate to the type of product under consideration.

***Odour*:** it must not hint that any biochemical change is going on.

Cleanness: the number of impurities must conform to established standards of quality.

Infestation: the absence of insects or other living organisms must be ascertained.

Generally, multiple criteria combine to define the quality of the products, and they also take into account cultural aspects related to community eating habits. In Senegal, for example, broken rice is highly prized by consumers; for this reason, the degree of breakage, as a standard of rice quality, obviously has less importance than in other contexts.

Losses in quality are mainly the result of mechanical constraints undergone by the product, the action of pests (insects, rodents) and micro-organisms (moulds), or the chemical changes produced within the grains under the effect of environmental conditions (temperature, humidity, duration of storage). These losses can occur at any stage of production, especially during

Losses due to physical condition

These depend on the physical condition of the grain during a given stage of the post-harvest system. The physical characteristics generally considered in evaluating the incidence of such losses are: shape and size of the grains, percentage of moisture, presence of impurities (foreign grains, grains that have germinated, are broken, deteriorated or damaged; pebbles, earth, plant residues, fragments of glass or metal, animal hairs or excrement, etc.), degree of infestation by insects or micro-organisms.

Losses due to change in food qualities

These losses, which are especially critical when the grains are intended for human consumption, result from alteration of the organoleptic features (aspect, taste, smell), from the degree of innocuity of the product (absence of toxic products such as toxins, pesticide residues, etc.), and from alteration in its content of vitamins, proteins, fats, glucides and other important nutrients.

Losses due to change in germinative properties

If marketable seeds are desired, the grain must not show altered germinative properties. These can be defined by the rate and percentage of germination, the vigour (stress resistance), the growth-rate of the seedlings and the absence of anomalies in the plants thus obtained. The alteration of these properties brings about production losses by decreasing the capability of the grain to germinate.

Economic losses

A reduction in the quantities or qualities of grain means a corresponding commercial loss that is evidenced as a loss of money. But beyond these direct economic losses, an evaluation of losses should also take account of some factors within the post-harvest system that can hamper the growth of production and of income. These include production systems, work schedules and methods, infrastructure, organization models, credit mechanisms etc. Some examples will illustrate this point.

For example, adoption of mechanized or semi-mechanized systems for some operations (harvesting, threshing, drying, etc.) can cut working time while, at the same time, permitting an increase in production by reducing the labour required and exploiting the land to better advantage. Commercially, if the transport system is inadequate, the farmer may find it impossible to sell his products within the required time-limits and in the places where market prices are the most attractive. The fact of having to forgo a potential profit is beyond a doubt a loss of money. If a farmer is not able to store products in complete security in existing storage buildings, he may be obliged to sell his production immediately after the harvest, thus becoming unable to profit by market prices when they are at their best. Once again, missing a profit is an economic loss for the farmer.

The consequences of such situations often go beyond individual losses of money: they affect production and the entire national economy.

CRITICAL FACTORS CONTRIBUTING TO POST-HARVEST LOSS

Postharvest losses vary greatly among commodities and production areas and seasons. As a product moves in the postharvest chain, PHLs may occur from a number of causes, such as improper handling or bio deterioration by microorganisms, insects, rodents or birds. An important factor in developed countries is that a large amount of the food produced is not eaten but discarded, for reasons such as it was left on the plate after a meal or it passed its expiry date. In contrast, failure to consume available food in Less Developed Countries (LDCs) is not a reported concern; instead the low-quality food remaining in markets at the end of the day is sustenance for the very poor. The issue in LDCs is inefficient postharvest agricultural systems that lead to a loss of food that people would otherwise eat, sell or barter to improve their livelihoods (Hodges et al, 2010).

There are internal and external factors contributing to postharvest loss.

Internal Factors

The following sections describe PHL occurring at all stages in the food supply chain from the moment of harvesting, to handling, storage, processing and marketing.

Harvesting

The time of harvesting is determined by degree of crop maturity and weather conditions. Primary causes of losses at the harvest stage include:

- Absence of an established maturity index index for local export markets. 1 for some commodities, and/ or lack of maturity

- Low adoption of established indices, as price and distance to market influence adoption.

- Poor weather at harvesting time which affects the operations and functionality of harvesting machines or human labor and usually increases the moisture content of the harvested products.

NB. Loss is also caused by employment of improper harvesting methods such as: Rough handling; untimely harvesting; lack of appropriate and/ or poorly-designed harvesting tools, equipment, and harvesting containers.

Pre-cooling

Loss at this stage is primarily due to the high cost and lack of availability of pre-cooling facilities, inadequate training on pre-cooling technology at the commercial scale, and lack of information on cost benefits of pre-cooling technology.

Transportation

Primary challenges in the transportation stage of the supply chain include poor infrastructure

(roads, bridges, etc.), lack of appropriate transport systems, and a lack of refrigerated transport. In most developing countries, roads are not adequate for proper transport of horticultural crops. Also, transport vehicles and other modes of transport, especially those suitable for perishable crops, are not widely available. This is true both for local marketing and export to other countries. Most producers have small holdings and cannot afford to purchase their transport vehicles. In a few cases, marketing organizations and cooperatives have been able to acquire transport vehicles but cannot alleviate poor road conditions (Kader, 2002).

Storage

Facilities, hygiene, and monitoring must all be adequate for effective, long-term storage. In closed structures (granaries, warehouses, hermetic bins, silos), control of cleanliness, temperature, and humidity is particularly important. It also very important to manage pests and diseases since damage caused by pests (insects, rodents) and molds can lead to deterioration of facilities (e.g. mites in wooden posts) and result in losses in quality and food value as well as quantity.

Grading

Proper packing and packaging technologies are critical in order to minimize mechanical injury during the transit of produce from rural to urban areas. Causes of PHL in the grading stages are: lack of national standards and poor enforcement of standards, lack of skill, awareness, and financial resources.

Packaging and labelling

After harvest, fresh fruits and vegetables are generally transported from the farm to either a packing house or distribution centre. Farmers sell their produce in fresh markets or in wholesale markets. At the retail level, fresh produce is sold in an unpackaged form or is tied in bundles. This type of market handling of fresh produce greatly reduces its shelf life if it is not sold quickly.

Secondary processing

Causes of post-harvest loss in this stage include limited availability of suitable varieties for processing, lack of appropriate processing technologies, inadequate commercialization of new technologies and lack of basic infrastructure, inadequate facilities and infrastructure, and insufficient promotion of processed products.

Biological

Biological causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with color, texture, flavour, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown. The rate of biological deterioration depends on several environmental factors, including temperature, relative humidity, air velocity, and atmospheric composition (concentration of oxygen, carbon dioxide, and ethylene), and sanitation procedures. All these

factors have been discussed by numerous authors (Kitimoja and Gorny, 1999; Kader, 2002; Gross et al, 2002).

Microbiological

Micro-organisms cause damage to stored foods (e.g. fungi and bacteria). Usually, micro organisms affect directly small amount of the food but they damage the food to the point that it becomes unacceptable. Toxic substances elaborated by molds (known as mycotoxins) cause loss in food quality and nutritional value.

Chemical

Many of the chemical constituents naturally present in stored foods spontaneously react causing loses of colour, flavour, texture and nutritional value. One such reaction is the maillard relationv that causes browning and decolouration in dried fruits and other product. There can also be harmful chemicals such as pesticides or obnoxious chemical such as lubricating oil (Atanda et al, 2011).

External Factors

Factors outside of the food supply chain can cause significant postharvest loss. These factors can be grouped into two primary categories: environmental factors and socio-economic patterns and trends.

Environmental factors

Climatic conditions, including wind, humidity, rainfall, and temperature influence both the quantity and quality of a harvest (Grolleaud 2002).

a) Temperature

In general, the higher the temperature the shorter the storage life of horticultural products and the greater the amount of loss within a given time, as most factors that destroy the produce or lower its quality occur at a faster rate as the temperature increases (Atanda et al, 2011).

b) Humidity

There is movement of water vapour between stored food and its surrounding atmosphere until equilibrium of water activity in the food and the atmosphere. A moist food will give up moisture to the air while a dry food will absorb moisture from the air. Fresh horticultural products have high moisture content and need to be stored under conditions of high relative moisture loss and wilting (except for onions and garlic). Dried or dehydrated products need to be stored under conditions of low relative humidity in order to avoid adsorbing moisture to the point where mold growth occurs (Atanda et al, 2011).

c) Altitude

Within a given latitude the prevailing temperature is dependent upon the elevation when other

factors are equal. There is on the average a drop in temperature of 6.5°C (Atanda et al, 2011) for each kilometre increase in elevation above sea level. Storing food at high altitudes will therefore tend to increase the storage life and decrease the losses in food provided it is kept out of direct rays of the sun (FAO, 1983).

d) Time

The longer the time the food is stored the greater is the deterioration in quality and the greater is the chance of damage and loss. Hence, storage time is a critical factor in loss of foods especially for those that have a short natural shelf life.

Socio-economic factors

Social trend such as urbanization has driven more and more people from rural area to large cities, resulting in a high demand for food products at urban centres, increasing the need for more efficient and extended food supply chains (Parfitt et al. 2010). Other socio-economic factors are linked with grain importation which can introduce new insect species, hence posing a very significant problem. Not only is the imported grain at risk, but the native grain as well. For example, in 1980, the introduction of a new insect species to Africa along with grain importation created weight losses of up to 30% in just 3-6 months of storage (Boxall 2001).

TECHNOLOGIES AND PRACTICES TO REDUCE/ CONTROL POST-HARVEST LOSSES

There are many examples of promising practices. These range from training in improved handling and storage hygiene to the use of hermetically sealed bags and household metallic silos, and are supported by enhancing the technical capabilities of local tinsmiths in silo construction. (The World Bank et al, 2011).

The choice of technology package depends on circumstances, such as the scale of production, crop type, prevailing climatic conditions, and the farmers affordability and willingness to pay (which are linked to social, cultural and economic implications of adoption). Some strategies for reducing postharvest losses are listed below:

1. Simple and basic strategy of reducing post-harvest food losses for any type of commodity. A systematic analysis of each commodity production and handling system is the logical first step in identifying an appropriate strategy for reducing postharvest losses (Bell et al, 1999; Kitinoja and Gorny, 1999).

2. Strategies of reducing post-harvest food losses in **cereal grains.**



Stage in the food System	Description and Strategy
Harvesting	In tropical countries in general, most grains have a single annual harvesting season, although in bimodal rainfall areas there may be two harvests (e.g. Ghana and Uganda). African producers harvest grain crops once the grain reaches physiological maturity (moisture content is 20-30%) (FAO, World Bank, 2011). At this stage the grain is very susceptible to pest attacks. Poor farmers sometimes harvest crops too early due to food deficiency or the desperate need for cash. In this way, the food incurs a loss in nutritional and economic value, and may get wasted if it is not suitable for consumption. Quality cannot be improved after harvest, only maintained; therefore, it is important to harvest at the proper maturity stage and at peak quality
Drying	Grains should be dried in such a manner that damage to the grain is minimized and moisture levels are lower than those required to support mold growth during storage (usually below 13-15%). This is necessary to prevent further growth of fungal species that may be present on fresh grains. The harvested crop may be dried in the yard or in a crib.
Threshing / Shelling	For some grains, particularly millet and sorghum, threshing may be delayed for several months after harvest and the unthreshed crop stored in open cribs. In the case of maize, the grain may be stored on the cob with or without sheathing leaves for some months, or the cobs may be shelled and grain stored. Some machinery suitable for small small scale operation exists such as: maize shellers; Rice mechanical threshers which are actively being promoted by the International Rice Research Institute (IRRI)

Winnow/ Cleaning	Usually done prior to storage or marketing if the grain is to be sold directly. For the majority of the smallholder, this process is manually. It is relatively ineffective from a commercial perspective, since grain purchased from smallholders frequently requires screening to remove stones, sand, and extraneous organic matter. There is little incentive for smallholders to provide well cleaned grain for marketing; as a result profits from sales are limited.
On farm storage	Post harvest losses at storage are associated with both poor storage conditions and lack of storage capacity. It is important that stores be constructed in such a way as to provide: dry, well vented conditions allowing further drying in case of limited opportunities for complete drying prior to storage; protection from rain and drainage of ground water; and protection from entry of rodents and birds and minimum temperature fluctuations

3. Strategies of reducing post-harvest food losses in perishable crops **(roots and tubers).**



Root and tuber crops are still living organisms after they have been harvested and losses that occur during storage arise mainly from their physical and physiological condition. The main causes of loss are associated with mechanical damage, physiological condition (maturity, respiration, water loss, sprouting), diseases and pests. To ensure effective storage of root and tuber crops, these major causative factors need to be properly understood and, where appropriate, be properly controlled, taking into account the socio-economic factors which prevail in the areas of production and marketing (FAO, 1985).

Stage in the food System	Description and Strategy
Harvesting	It is the most important phase. Unless this operation is carried out with maximum efficiency, later prevention of food loss activities may be a waste of time. If, for example, roots and tubers are bruised or otherwise damaged during harvesting, consideration of improved handling or packaging is not likely to be worth while, since an early infestation with virus and mould will occur and rotting will have started. If harvesting operations are correctly undertaken there is greater scope for later introduction of improved methods. Provision of the proper tools and equipment for harvesting and training workers in their correct use should be a priority prevention of food loss activity.
Handling	The skin of roots and tubers is an effective barrier to most of the opportunistic bacteria and fungi that cause rotting of the tissues. Breaking of the skin also stimulates physiological deterioration and dehydration. Careful digging and movement of roots and tubers significantly reduces post harvest losses.
Packing	Packing of the roots is usually done in the field Farmers commonly pack the roots and strategically place the large roots at the top on the bag to quickly attract the buyer on first sight. Packing should minimize deterioration of the roots within the container and cushion against impact and compression. During packing in the field care must be taken to minimise physical damage that results from impact bruises due to stacking and over filling of bags, abrasion or vibration bruises due to root movement against each other. Therefore packages should be neither loose (to avoid vibration bruising during transport) nor over filled, and should provide good aeration.

Transportation	Temperature management is critical during long distance transport, so loads must be stacked to enable proper air circulation to carry away heat from the produce itself as well as incoming heat from the atmosphere and off the road. In many developing countries traditional baskets and various types of trays or buckets are used for transporting produce to the house or to village markets. These are usually of low cost, made from readily available material and serve the purpose for transport over short distances. But, they have many disadvantages in large loads carried over long distances (i.e. they are difficult to clean when contaminated with decay organisms). However, packaging can be a major item of expense in produce marketing, especially in developing countries where packaging industries are not well developed. The selection of suitable containers for commercial scale marketing requires very careful consideration. Among the various types of packaging material that are available: natural and synthetic fibre sacks and bags as well as moulded plastic boxes seem to be more suitable and have greater promise for packaging roots and tubers and for their transport to distant markets.
Storage	The following three things must be done to ensure successful storage of fresh roots and tubers. i) Carefully select only top quality roots and tubers without any signs of handling or pest or disease damage for storage. ii) keep them in specially designed stores and iii) check the stores at regular intervals. Many farmers do not routinely store fresh roots and tubers leave them in the ground , but until required. It is possible to store fresh roots successfully in specially constructed pits or in mounds, or clamp stores. For example, when storing potatoes, a field storage clamp is a low cost technology that can be designed using locally available materials for ventilation and insulation.

Processing	Root and tuber crops (cassava, sweet potato, yam etc) are both important household food security and income generating crops in many developing countries. Overcoming the perishability of the crops, improving marketing, enhancing nutritional value and adding economic value through processing are the main postharvest losses. strategic areas in for reducing The various processing techniques are listed below: peeling and washing, grating, pressing/ fermentation, sieving, frying/drying. All these techniques into: Traditional methods can be divided such as drying (production of dehydrated chips); processing into 'gari' production of bread; production of and farinha de mandioca; and production 'attieke' . Improved methods of production of dehydrated chips such as: simple processing machinery developed by Potato Center " CIP " the International (washer, peeler, slicer and dryer). An important aspect of processing is that it is often intended to prolong the preservation under ambient conditions. The most appropriate products in this respect are dehydrated root and tubers products such as: potato products (starch and flakes) Besides permitting better preservation, the drying and processing of root and tubers into dried chips and flour offers other advantages such as: - facilitating transport and increased shelf life - creating new opportunities for the farmer such as new markets and new sources of income. Metal storage bins or water tanks made from smooth or corrugated galvanised metal sheets are used for products. storing dried products. Dehydration or sun drying is the simplest and lowest cost method of preservation and should be more widely promoted and used in developing countries because it converts a perishable commodity into a stable item with long storage life.

4. Strategies of reducing post-harvest food losses in perishable crops **(fruits and vegetables)**



It is important to highlight that, some varieties of the same crop store better than others. Therefore, to reduce food loss and to achieve maximum shelf-life, only varieties known to store well should be stored.

Stage in the food System	Description and Strategy
Harvesting	Harvesting should be carried out as carefully as possible to minimize mechanical injury such as scratches, punctures and bruises to the crop. The time of the day when harvesting is done also affects produce quality and shelf-life. In general, ring the coolest time of the day (early morning) is desirable; the produce is not exposed to the heat of the sun and the work efficiency of the harvesters is higher. If harvesting during the hotter part of the day cannot be avoided, the produce should be kept shaded in the field to minimize product weight loss and wilting.
Handling	Mechanical injury provides sites for pest attack and increases physiological losses. Therefore, avoid mechanical injury to the crop while handling. Because of their soft texture, all horticultural products (fruits and vegetables) should be handled gently to minimize bruising and breaking of the skin. The skin of horticultural products is an effective barrier to most of the opportunistic bacteria and fungi that cause rotting of the tissues. Breaking of the skin also stimulates physiological deterioration and dehydration. Reducing the number of times the commodity is handled reduces the extent of mechanical damage.

Sorting and Cleaning	Systematic sorting or grading coupled with appropriate packaging and storage, will extend shelf life, maintain wholesomeness, freshness, and quality, and substantially reduce losses and marketing costs. Sorting is done to separate poor produce from good produce, and further classify the good produce based on other quality parameters like size. (Bautista and Acedo, 1987).
Packaging	Proper packing is essential to maintain the freshness of leafy vegetable. Packaging should be designed to prevent premature deterioration in product quality, in addition to serving as a handling unit (Bautista and Acedo, 1987). Use clean, smooth ventilated containers for packaging. This is a very important factor in cutting down losses in these crops during harvesting, transportation, marketing and storage. Use containers that are appropriate for packaging containers can be found in the crop.
Transportation	Minimizing losses during transport necessitates special attention to vehicles, equipment, infrastructure, and handling. Load and unload transport vehicles carefully. Use clean, well ventilated vehicle covered at the top for transportation. Transport crops during the cool part of the day by driving carefully over smooth roads to minimize damage to crop. Fresh produce must not be watered prior to loading, as this will lead to decay, rotting and extensive losses. Major causes of losses are improper handling during loading and unloading.
Storage	Only crops with high initial quality can be stored successfully; it is therefore essential to ensure that only crops of the highest quality (mature, undamaged) are stored. Shelf life can be extended by maintaining a commodity at its optimal temperature, relative humidity and environmental conditions.
Processing	Processing is an important value added activity that stabilizes and diversifies food supplies and creates employment and income opportunities. It can minimize the high perishability problem of leafy vegetables. Processed products are also more stable, have improved digestibility and permit a better diet diversity, giving consumers access to a wider choice of products and a wider range of vitamins and minerals. Few processing technologies are listed: Drying, salting, fermenting and pickling

5. Improve the existing store types

One approach to reducing PHL during storage is either by improving existing store types so that they perform better, or by introducing existing traditional store types (mud silo) more effective than those usually used by the communities or by introducing new storage type (metal silo). Mud silo (source: Rick Hoges, 2011) Metal silo (source: spore magazine, 2011) The household metal silo is one of the key post-harvest technologies in the fight against

hunger and for food security. It is a simple structure that allows grains to be kept for long periods and prevents attack from pests such as rodents, insects and birds. If the grains have been properly dried (<14 % moisture in the case of cereals and <10 % in the case of pulses and oilseeds) and the household metal silo is kept under cover, there are no problems of moisture condensation inside it.

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